MIRROR ANGLE CONTROL APPARATUS AND POWER MIRROR SYSTEM HAVING THE SAME

CROSS REFERENCE TO RELATED APPLICATION

This application is based on and incorporates herein by reference Japanese Patent Application No. 2002-351519 filed on December 3, 2002.

BACKGROUND OF THE INVENTION

1. Field of the Invention:

The present invention relates to a mirror angle control apparatus and a power mirror system having the same.

2. Description of Related Art:

One type of power mirror system (also referred to as a power side mirror system or simply referred to as a power side mirror) arranged at a door of a vehicle has a mirror angle control apparatus that tilts a mirror (i.e., a mirror plate) in a vertical direction and also in a horizontal direction.

The mirror angle control apparatus includes a vertical angle adjuster and a horizontal angle adjuster. The vertical angle adjuster tilts the mirror in the vertical direction. The horizontal angle adjuster tilts the mirror in the horizontal direction. This type of mirror angle control apparatus is disclosed in, for example, Japanese Unexamined Utility Model Publication No. 6-49199 and Japanese Unexamined Utility Model Publication No. 6-32194.

In the above mirror angle control apparatus, one motor is provided in the vertical angle adjuster, and another motor is

provided in the horizontal angle adjuster. The mirror is tilted in the vertical direction and in the horizontal direction by separately controlling the motors.

Thus, in the above mirror angle control apparatus, the two motors are provided in the vertical angle adjuster and the horizontal angle adjuster, respectively. This arrangement creates difficulties in size reduction and weight reduction of the mirror angle control apparatus and thus of the power mirror system. Furthermore, this arrangement causes an increase in the number of the components and also an increase in manufacturing costs.

SUMMARY OF THE INVENTION

The present invention addresses the above disadvantages. Thus, it is an objective of the present invention to provide a mirror angle control apparatus, which allows minimization of a size, weight and manufacturing costs of the mirror angle control apparatus. It is another objective of the present invention to provide a power mirror system that has such a mirror angle control apparatus.

To achieve the objectives of the present invention, there is provided a mirror angle control apparatus for a power mirror system that includes a mirror. The mirror angle control apparatus includes a single electric motor and first and second reciprocable members. The first and second reciprocable members are arranged between the motor and the mirror and are selectively reciprocated by rotational force conducted from the motor to tilt the mirror. When the motor is rotated in a first rotational

direction, the second reciprocable member is held stationary, and the first reciprocable member is reciprocated to tilt the mirror in a vertical direction. When the motor is rotated in a second rotational direction, which is opposite from the first rotational direction of the motor, the first reciprocable member is held stationary, and the second reciprocable member is reciprocated to tilt the mirror in a horizontal direction. There is also provided a power mirror system that includes a mirror and the above mirror angle control apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention, together with additional objectives, features and advantages thereof, will be best understood from the following description, the appended claims and the accompanying drawings in which:

FIG. 1 is a fragmented descriptive view showing an internal structure of a mirror angle control apparatus according to an embodiment of the present invention while partially removing part of a casing of the mirror angle control apparatus and fully removing top covers of secondary gears for the sake of clarity;

FIG. 2 is a partial cross sectional view along line II-II in FIG. 1;

FIG. 3A is a partial cross sectional view along line III-IIIA in FIG. 1;

FIG. 3B is a partial enlarged view of a region enclosed in a circle IIIB in FIG. 3A;

FIG. 4 is a descriptive view showing engagement of a slide

piece with an endless helical groove of a reciprocable member while removing a slide support from the reciprocable member;

FIG. 5A is a plan view of the slide piece;

FIG. 5B is a cross sectional view of the slide piece along line VB-VB in FIG. 5A;

FIG. 6 is a descriptive view showing a structure of a power mirror system according to the embodiment;

FIG. 7 is a partial fragmentary cross sectional view of the power mirror system of FIG.6 seen from a bottom side of the power mirror system;

FIG. 8A is a schematic partial view showing a modification of the mirror angle control apparatus of the embodiment;

FIG. 8B is a partial enlarged view of a region enclosed in a circle VIIIB in FIG. 8A; and

FIG. 9 is a schematic partial enlarged view showing a modification of the reciprocable member of the embodiment.

DETAILED DESCRIPTION OF THE INVENTION

With reference to FIG. 1, a mirror angle control apparatus 10 according to an embodiment of the present invention is used in, for example, a power side mirror system of a vehicle provided in a door to adjust a tilt angle of a mirror of the power side mirror system.

The mirror angle control apparatus 10 includes a casing 11, a motor 12, a worm gear 13, two primary gears (i.e., first and second primary gears) 14a, 14b, two secondary gears (i.e., first and second secondary gears) 15a, 15b and two reciprocal members

(i.e., first and second reciprocable members) 16a, 16b.

The motor 12 is secured in the casing 11, and the worm gear 13 is secured around a rotatable shaft 17 of the motor 12. The primary gears 14a, 14b are disposed on the opposite sides (first and second sides) of the worm gear 13 and are rotatably secured to the casing 11. The primary gears 14a, 14b are meshed with the worm gear 13.

As shown in FIG. 2, a first intermediate gear 18a is coaxially secured to the center of the primary gear 14a and is meshed with the corresponding secondary gear 15a. A gear diameter of the intermediate gear 18a is smaller than a gear diameter of the primary gear 14a.

Similar to the primary gear 14a, a second intermediate gear 18b is coaxially secured to the center of the primary gear 14b and is meshed with the corresponding secondary gear 15b.

Each secondary gear 15a, 15b includes a one-way clutch mechanism, which conducts rotational force of the secondary gear 15a, 15b only in one way and prevents conduction of the rotational force in the opposite way.

More specifically, three driving-side engaging portions (in a form of an engaging wall portion in the present embodiment) 19a are formed in an inner peripheral wall of a generally circular recess 15a1 formed in the secondary gear 15a. A first clutch plate 21a, which has three driven-side engaging portions (in a form of an engaging projection in the present embodiment) 20a, is received in the recess 15a1 of the secondary gear 15a.

Similar to the secondary gear 15a, three driving-side

engaging portions (in a form of an engaging wall portion in the present embodiment) 19b are formed in an inner peripheral wall of a generally circular recess 15b1 formed in the secondary gear 15b. A second clutch plate 21b, which has three driven-side engaging portions (in a form of an engaging projection in the present embodiment) 20b, is received in the recess 15b1 of the secondary gear 15b.

The primary gear 14a, the secondary gear 15a and the intermediate gear 18a form a first speed reducing gear arrangement, which reduces a rotational speed transmitted from the worm gear 13 to the first one-way clutch mechanism 19a, 21a in comparison to a rotational speed of the worm gear 13. Furthermore, the primary gear 14b, the secondary gear 15b and the intermediate gear 18b form a second speed reducing gear arrangement, which reduces a rotational speed transmitted from the worm gear 13 to the second one-way clutch mechanism 19b, 21b in comparison to a rotational speed of the worm gear 13.

With reference to FIG. 1, when the secondary gear 15a is rotated in a direction of arrow Ra1 (first rotational direction), the driving-side engaging portions 19a engage the driven-side engaging portions 20a. Thus, the clutch plate 21a is rotated together with the secondary gear 15a. On the other hand, when the secondary gear 15a is rotated in a direction of arrow Ra2 (second rotational direction), which is opposite to the direction of arrow Ra1, the driving-side engaging portions 19a are disengaged from the driven-side engaging portions 20a or simply do not engage the driven-side engaging portions 20a, and thus the

secondary gear 15a is raced, i.e., is rotated relative to the clutch plate 21a without driving the clutch plate 21a.

Similarly, when the secondary gear 15b is rotated in a direction of arrow Rb1 (first rotational direction), the driving-side engaging portions 19b engage the driven-side engaging portions 20b. Thus, the clutch plate 21b is rotated together with the secondary gear 15b. On the other hand, when the secondary gear 15b is rotated in a direction of arrow Rb2 (second rotational direction), which is opposite from the direction of arrow Rb1, the driving-side engaging portions 19b are disengaged from the driven-side engaging portions 20b or simply do not engage the driven-side engaging portions 20b, and thus the secondary gear 15b is raced, i.e., is rotated relative to the clutch plate 21b without driving the clutch plate 21b.

As shown in FIG. 3A, in the mirror angle control apparatus 10 of the present embodiment, a top cover C covers an end opening of the recess 15a1 of the secondary gear 15a, in which the clutch plate 21a is received. In FIGS. 1 and 6, the top cover C is removed from the secondary gear 15a for the sake of clarity. The secondary gear 15b is constructed in a manner similar to the secondary gear 15a and thus will not be described in great detail.

As shown in FIG. 3A, a first cylindrical slide support (serving as a first rotatable member of the present invention) 22a is secured to the clutch plate 21a to rotate integrally with the clutch plate 21a.

A cylindrical blind hole 23 extends in the slide support 22a in a longitudinal direction of the slide support 22a and is

opened in one end (left end in FIG. 3A) of the slide support 22a. The reciprocable member 16a, which is made of an elongated cylindrical body, is received in the blind hole 23. The reciprocable member 16a is reciprocable relative to the slide support 22a in a direction of arrow X in FIG. 3A and has a spherical pivot 24a, which is integrated in a distal end of the reciprocable member 16a. A first endless helical groove 25 is formed to provide a Napier screw in an outer peripheral surface of the reciprocable member 16a. The endless helical groove 25 includes two helical groove sections 25a, 25b, which extend in opposite helical directions, respectively, and are connected one another at opposite ends of the reciprocable member 16a to form an endless path.

A first slide piece 26 is provided in the blind hole 23 of the slide support 22a and engages the endless helical groove 25 of the reciprocable member 16a. Through the engagement with the endless groove 25, the slide piece 26 drives the reciprocable member 16a such that the reciprocable member 16a is reciprocated relative to the slide support 22a when the slide support 22a is rotated. More specifically, as shown in FIGS. 3B to 5B, the slide piece 26 has a through hole 26a that penetrates through the slide piece 26 at a center of the slide piece 26. A pin 22a1 extends from the inner peripheral wall of the blind hole 23 of the slide support 22a in a direction generally perpendicular to a reciprocating direction of the reciprocable member 16a and is received in the through hole 26a of the slide piece 26. The slide piece 26 is rotatable about a central axis (serving as a

rotational axis of the slide piece 26) of the pin 22a1. Axial ends of the slide piece 26 are tapered, and an inner surface of the slide piece 26, which is engaged with an arcuate bottom surface of the endless helical groove 25, is arcuately curved to follow the curved surface of the endless helical groove 25, as shown in FIGS. 4-5B. A curvature of the inner surface of the slide piece 26 is smaller than a curvature of the bottom surface of the endless helical groove 25, so that only a center portion of the inner surface of the slide piece 26 slidably engages the arcuate bottom surface of the endless helical groove 25. With the above arrangement of the slide piece 26, when the slide piece 26 moves from one of the helical groove sections 25a, 25b to the other one of the helical groove sections 25a, 25b, the slide piece 26 can change its moving direction.

Furthermore, with the provision of the one-way clutch mechanism in the second gear 15a and the provision of the slide piece 26 in the slide support 22a, the reciprocable member 16a is reciprocated in the reciprocating direction that is parallel to the rotational axis of the slide support 22a when the secondary gear 15a is rotated in the direction of arrow Ra1.

Similar to the slide support 22a, a cylindrical blind hole (not shown) extends in a second slide support 22b (serving as a second rotatable member of the present invention) in a longitudinal direction of the slide support 22b. A second reciprocable member 16b, which is made of an elongated cylindrical body, is received in the cylindrical blind hole of the slide support 22b, which is similar to the cylindrical blind

hole 23 of the slide support 22a.

The reciprocable member 16b has a shape similar to the reciprocable member 16a. Furthermore, the reciprocable member 16b has a spherical pivot 24b, which is integrated in a distal end of the reciprocable member 16b. An endless helical groove similar to the endless helical groove 25 is formed in an outer peripheral surface of the reciprocable member 16b. The endless helical groove includes two helical groove sections, which are similar to the helical grooves 25a, 25b. Like the helical grooves 25a, 25b, the two helical groove sections of the endless helical groove extend in opposite helical directions, respectively, and are connected one another at opposite ends of the reciprocable member 16a to form an endless path.

A slide piece (not shown), which has a shape similar to the slide piece 26, is provided in a blind hole of the slide support 22b and engages the endless helical groove of the reciprocable member 16b to move along the endless path of the endless helical groove.

Similar to the reciprocable member 16a, the reciprocable member 16b reciprocates in a reciprocating direction, which is parallel to the rotational axis of the slide support 22b, when the secondary gear 15b is rotated in the direction of arrow Rb1.

A power supply terminal (not shown), which is connected to a power application terminal 27 of the motor 12, is formed in the casing 11. When electric power is supplied from an external power source to the power supply terminal (not shown) of the casing 11, the motor 12 is rotated.

When the electric power is supplied from the external power source to the motor 12, the rotatable shaft 17 of the motor 12 is rotated at a constant rotational speed. Furthermore, upon switching of polarities of the external power source, the rotational direction of the rotatable shaft 17 is changed from one direction to the other direction, and vice versa.

With reference to FIG. 1, securing portions 28 are formed in an outer surface of the casing 11. Each securing portion 28 includes a through hole 28a, which penetrates through the securing portion 28 and has an inner diameter that allows insertion of, for example, a screw (not shown) in the through hole 28a. Through the securing portions 28, the mirror angle control apparatus 10 is secured in a power mirror system 30, which will be described in greater detail below.

The power mirror system 30, which includes the mirror angle control apparatus 10, will be described with reference to FIGS. 6 and 7. In order to facilitate understanding of an internal structure of the power mirror system 30, a mirror (mirror plate) 50, which is described in greater detail, is indicated by a dot-dash line in FIG. 6.

The power mirror system 30 shown in FIGS. 6 and 7 is arranged in, for example, a door or any other appropriate part of a vehicle to provide a rear view of the vehicle to a vehicle driver.

The power mirror system 30 of the present embodiment includes the mirror angle control apparatus 10, a mirror housing 40, the mirror 50 and a mirror holder 60 (FIG. 7).

The mirror housing 40 is integrally connected to the

vehicle door and is formed as a recessed body or a cup shaped body, which has an opening 41 that is directed to a rear end of the vehicle. As shown in FIG. 7, a plurality of bosses 42 is formed in an interior base of the mirror housing 40. Each securing portion 28 of the mirror angle control apparatus 10 is secured to a corresponding one of the bosses 42 through a securing element 70, so that the mirror angle control apparatus 10 is integrally secured to the mirror housing 40.

The mirror 50 is secured to the mirror holder 60 such that the mirror 50 generally covers the opening 41 of the mirror housing 40. A vehicle rear side surface 50a of the mirror 50 is formed as a specular surface, i.e., a mirror surface to allow the driver to have a rear side view.

On an opposite side of the mirror holder 60, which is opposite from the mirror 50, two pivot holders 61a, 61b are provided, as shown in FIG. 7. The pivots 24a, 24b are fitted into the pivot holders 61a, 61b, respectively.

The pivot 24a and the pivot holder 61a form a first universal joint assembly, and the pivot 24b and the pivot holder 61b form a second universal joint assembly. With this arrangement, the reciprocable members 16a, 16b are integrated with the mirror holder 60 in a manner that allows swing movement of the mirror holder 60.

With reference to FIG. 6, when the mirror angle control apparatus 10 is integrally secured to the mirror housing 40, the pivot 24a (more specifically, the central axis of the first reciprocable member 16a) of the mirror angle control apparatus

10 is located at a vertically lower side of the mirror 50 along a central vertical axis (vertical imaginary line) L1 of the mirror 50, which extends vertically through the center of the mirror 50. Furthermore, the pivot 24b (more specifically, the central axis of the second reciprocable member 16b) of the mirror angle control apparatus 10 is located at a horizontally outer side of the mirror 50 along a central horizontal axis (horizontal imaginary line) L2 of the mirror 50, which extends horizontally through the center of the mirror 50. However, the pivots 24a, 24b are not necessarily arranged in the above manner. That is, as long as the central axis of the first reciprocable member 16a intersects the central vertical axis L1 of the mirror 50 at a location spaced away from the center of the mirror 50, the pivot 24a can be placed any position (e.g., a position above the center of the mirror 50 in FIG. 6). Similarly, as long as the central axis of the second reciprocable member 16b intersects the central horizontal axis L2 of the mirror 50 at a location spaced away from the center of the mirror 50, the pivot 24b can be placed any position (e.g., a position on the left side of the center of the mirror 50 in FIG. 6).

The power mirror system 30 is manipulated trough a power mirror control switch arrangement (not shown), which is provided at a driver seat side in a passenger compartment of the vehicle.

The power mirror control switch arrangement includes a vertical angle control switch and a horizontal angle control switch (both not shown).

When the vertical angle control switch is turned on, the

motor 12 of the mirror angle control apparatus 10 shown in FIG. 6 is rotated in a normal direction (first rotational direction). Furthermore, when the horizontal angle control switch is turned on, the motor 12 is rotated in a reverse direction (second rotational direction).

In the above embodiment, the worm gear 13, the speed reducing gear arrangements 14a, 14b, 15a, 15b, 18a, 18b and the one-way clutch mechanisms 19a, 19b, 21a, 21b constitute a switchable type transmission mechanism that is arranged between the motor 12 and the first and second slide supports 22a, 22b.

It should be noted that the power mirror system 30 can be modified as follows. That is, when a transmission lever of the vehicle is shifted to a reverse position, the motor 12 of the mirror angle control apparatus 10 may be rotated in the normal direction to substantially tilt the mirror 50 in a downward direction of the vehicle.

Furthermore, a position sensor (not shown) may be provided to sense a position of each reciprocable member 16a, 16b, and the motor 12 may be operated based on a position signal outputted from the position sensor.

Next, operation of the power mirror system 30 will be described.

When the vertical angle control switch of the power mirror system is pressed, i.e., is turned on, electric power is supplied from the external power source (not shown) to the motor 12 shown in FIG. 6, so that the motor 12 is rotated in the normal direction. Thus, the worm gear 13 is rotated in the normal direction. Also,

the primary gears 14a and the intermediate gear 18a are rotated in the direction of arrow Ra3, and the primary gear 14b and the intermediate gear 18b are rotated in the direction of arrow Rb3.

When the primary gear 14a and the intermediate gear 18a are rotated in the direction of arrow Ra3, the secondary gear 15a is rotated in the direction of arrow Ra1. Thus, the driving-side engaging portions 19a engage the driven-side engaging portions 20a, and the secondary gear 15a and the clutch plate 21a are rotated in the direction of arrow Ra1.

When the primary gear 14b and the intermediate gear 18b are rotated in the direction of Rb3, the secondary gear 15b is rotated in the direction of arrow Rb2. Thus, engagement between the driving-side engaging portions 19b and the driven-side engaging portions 20b is released, and the secondary gear 15b is raced, i.e., is rotated relative to the clutch plate 21b.

Thus, when the secondary gear 15b is rotated relative to the clutch plate 21b, the clutch plate 21b is held stationary. As a result, the reciprocable member 16b does not reciprocate, and the mirror 50 does not tilt in the horizontal direction (left-right direction).

On the other hand, when the clutch plate 21a is rotated in the direction of arrow Ra1, the slide support 22a is rotated together with the clutch plate 21a. When the slide support 22a is rotated, the slide piece 26 is moved along one of the helical groove sections 25a, 25b of the endless helical groove 25 of the reciprocable member 16a. Thus, the reciprocable member 16a is moved forward or backward in the direction of arrow X in FIG. 3A.

When the slide piece 26 is in the helical groove section 25a, and the slide support 22a is rotated in the direction of arrow Ra1, the reciprocable member 16a is moved forward in a direction of arrow X1 in FIG. 3A.

When the reciprocable member 16a is moved forward in the direction of arrow X1, the vertically lower side of the mirror 50 shown in FIG. 6 is pushed by the pivot 24a. Thus, the mirror 50 is tilted vertically upward.

Then, when the vertical angle control switch is kept pressed, i.e., is kept turned on, the slide support 22a is kept rotated in the direction of arrow Ra1. Thus, the slide piece 26 is moved from the helical groove section 25a to the helical groove section 25b, so that the reciprocable member 16a, which has been moved forward in the direction of arrow X1, is now moved backward in a direction of arrow X2 shown in FIG. 3A.

When the reciprocable member 16a is moved backward, the vertically lower side of the mirror 50 shown in FIG. 6 is pulled by the pivot 24a. Thus, the mirror 50 is tilted vertically downward.

As described above, in the power mirror system 30 of the present embodiment, when the vertical angle control switch is kept turned on, the mirror 50 is kept tilted vertically, i.e., is kept swung vertically. Thus, the operator can turn off the vertical angle control switch when the mirror 50 is tilted to a desired vertical angle, so that the mirror 50 is adjusted to the desired vertical tilt angle.

When the horizontal angle control switch of the power

mirror system 30 is pressed, i.e., is turned on, electric power is supplied from the external power source (not shown) to the motor 12 shown in FIG. 6, so that the motor 12 is rotated in the reverse direction, which is opposite from the normal direction that is the rotational direction of the motor 12 at the time of pressing the vertical angle control switch. Thus, the worm gear 13 is rotated in the reverse direction. Also, the primary gears 14a and the intermediate gear 18a are rotated in the direction of arrow Ra4, and the primary gear 14b and the intermediate gear 18b are rotated in the direction of arrow Rb4.

When the primary gear 14b and the intermediate gear 18b are rotated in the direction of arrow Rb4, the secondary gear 15b is rotated in the direction of arrow Rb1. Thus, the driving-side engaging portions 19b engage the driven-side engaging portions 20b, and the secondary gear 15b and the clutch plate 21b are rotated in the direction of arrow Rb1.

When the primary gear 14a and the intermediate gear 18a are rotated in the direction of Ra4, the secondary gear 15a is rotated in the direction of arrow Ra2. Thus, engagement between the driving-side engaging portions 19a and the driven-side engaging portions 20a is released, and the secondary gear 15a is raced, i.e., is rotated relative to the clutch plate 21a.

Thus, when the secondary gear 15a is rotated relative to the clutch plate 21a, the clutch plate 21a is held stationary. As a result, the reciprocable member 16a does not reciprocate, and the mirror 50 does not tilt in the vertical direction (top-bottom direction).

On the other hand, when the clutch plate 21b is rotated in the direction of arrow Rb1, the slide support 22b is rotated together with the clutch plate 21b. In this way, the reciprocable member 16b is moved forward or backward.

When the slide support 22b is rotated in the direction of arrow Rb1, and the reciprocable member 16b is moved forward, the horizontally outer side of the mirror 50 is pushed by the pivot 24b. Thus, the mirror 50 is tilted horizontally inward. i.e., is tilted horizontally toward the center of the vehicle.

Then, when the horizontal angle control switch is kept pressed, i.e., is kept turned on, the reciprocable member 16b is moved backward. Then, the horizontally outer side of the mirror 50 is pulled by the pivot 24b, so that the mirror 50 is tilted horizontally outward.

As described above, in the power mirror system 30 of the present embodiment, when the horizontal angle control switch is kept turned on, the mirror 50 is kept tilted horizontally, i.e., is kept swung horizontally. Thus, the operator can turn off the horizontal angle control switch when the mirror 50 is tilted to a desired horizontal angle, so that the mirror 50 is adjusted to the desired horizontal tilt angle.

The present embodiment provide the following advantages.

(I) In the power mirror system 30 of the present embodiment, one of the reciprocable members 16a, 16b of the mirror angle control apparatus 10 can be selectively moved forward and backward depending on the rotational direction of the motor 12. Thus, unlike the prior art, it is not required to provide the two

motors to the two reciprocable members, respectively, to move the reciprocable members forward and backward. Thus, the number of components can be advantageously reduced to reduce the size and weight of the entire system, thereby allowing a reduction in the manufacturing costs.

(II) The primary gears 14a, 14b are arranged on the opposite sides of the worm gear 13 and are meshed with the worm gear 13. Each of the one-way clutch mechanisms is arranged between the corresponding secondary gear 15a, 15b and the corresponding slide support 22a, 22b and transmits the rotational force of the secondary gear 15a, 15b, which is rotated in one direction, to the corresponding slide support 22a, 22b. Since the mirror angle control apparatus 10 of the present embodiment includes such primary gears 14a, 14b and one-way clutch mechanisms, one of the two slide supports 22a, 22b can be selectively rotated by simply changing the rotational direction of the motor 12.

(III) Each reciprocable member 16a, 16b includes the endless helical groove 25, which has the two helical groove sections 25a, 25b, which extend in opposite helical directions, respectively, and are connected one another at the opposite ends of the reciprocable member 16a, 16b. Because of the endless helical groove 25, the reciprocable members 16a, 16b can be reciprocated only by the single directional rotation of the corresponding slide supports 22a, 22b.

The above embodiment can be modified as follows.

(a) In the above embodiment, the endless helical groove 25 is formed in each reciprocable member 16a, 16b, and the slide

piece 26 is rotatably held by the slide support 22a, 22b, which serves as the rotatable member. Each reciprocable member 16a, 16b is slidably engaged with the corresponding slide support 22a, 22b through the engagement between the endless helical groove 25 of the reciprocable member 16a, 16b and the slide piece 26 of the slide support 22a, 22b. However, the present invention is not limited to this arrangement.

For example, as shown in FIGS. 8A and 8B, the endless helical groove 25 can be formed in an inner peripheral surface of the corresponding slide support 22a. The slide piece 26, which is engaged with the endless helical groove 25 can be rotatably held by the corresponding reciprocable member 16a around a pin 16a1, which extends from an outer peripheral surface of the reciprocable member 16a in a direction generally perpendicular to a reciprocating direction of the reciprocable member 16a.

(b) In the above embodiment, a groove pitch of the endless helical groove is generally constant. However, the present invention is not limited to this.

For example, as shown in FIG. 9, in place of the endless helical groove 25 of the reciprocable member 16a, 16b, an endless helical groove 125 of a reciprocable member 116 can be used. The endless helical groove 125 has a first type region A and two second type regions B1, B2. The first type region A is provided in the center of the reciprocable member 116 and has a relatively small groove pitch. The second type regions B1, B2 are arranged on opposite sides of the first type region A and have a relatively large groove pitch, which is larger than the groove pitch of the

first type region A.

With this arrangement, when the tilt angle of the mirror 50 in the horizontal direction or in the vertical direction is relatively large (i.e., when it is not required to perform small angular adjustment of the mirror 50), the mirror 50 can be rapidly tilted.

(c) In the mirror angle control apparatus 10 of the above embodiment, the motor 12 is rotated at the constant speed. However, the present invention is not limited to this. For example, the rotational speed of the motor 12 can be varied by increasing or decreasing the voltage applied to the motor 12.

(d) In the mirror angle control apparatus 10 of the present embodiment, each secondary gear 15a, 15b is connected to the worm gear 13 through the corresponding primary gear 14a, 14b. However, the present invention is not limited to this. For example, each secondary gear 15a, 15b can be directly meshed with the worm gear 13.

(e) In the mirror angle control apparatus 10 of the present embodiment, each secondary gear 15a, 15b receives rotational force of the motor 12 through the corresponding primary gear 14a, 14b and the worm gear 13. However, the present invention is not limited to this. For example, each secondary gear 15a, 15b can receive the rotational force of the motor 12 through, for example, a belt or a chain.

Additional advantages and modifications will readily occur to those skilled in the art. The invention in its broader terms is therefore not limited to the described illustrative examples.